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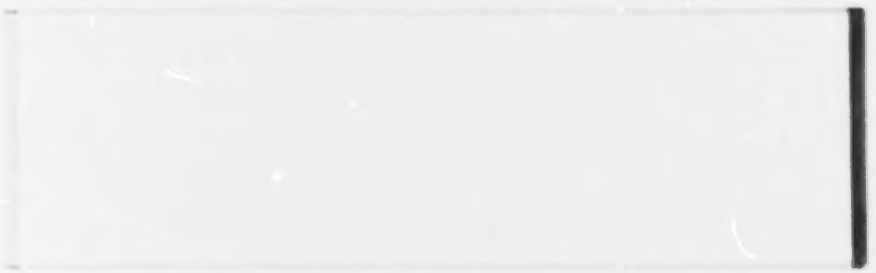

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R.N. Chakravorty

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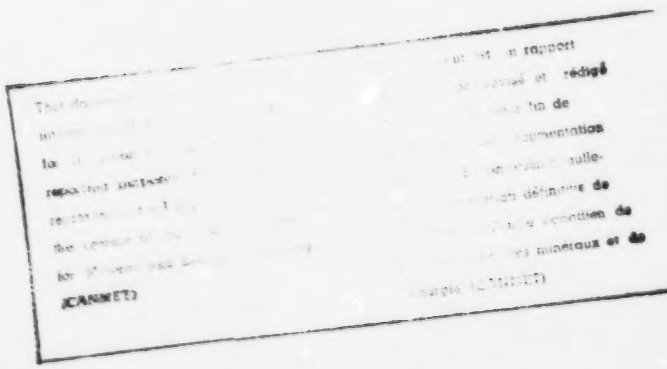

VISIT TO THE CENTRAL MINING RESEARCH STATION DHANBAD, INDIA,

by

R.N. Chakravorty*

ABSTRACT

A visit was made to the Central Mining Research Station, Dhanbad, India for a period of six weeks to review the work at CMRS mine fire laboratory, interact with the scientists and recommend measures so that R & D work related to mine fire control can be upgraded. This was carried out under the auspices of United Nation Development Programme as a TOKTEN consultant.

This report briefly describes the on-going research program at CMRS, Dhanbad with particular emphasis on mine fire, spontaneous combustion and biological control of methane.

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VISITE DE LA CENTRAL MINING RESEARCH STATION, DHANBAD, INDE

par

R.N. Chakravorty*

RESUME

Une visite de six semaines a été effectuée à la Central Mining Research Station de Dhanbad en Inde pour examiner le travail effectué au laboratoire de recherche sur les incendies dans les mines de la CMRS, échanger avec les scientifiques et recommander des mesures pour améliorer la R-D sur les incendies dans les mines. Elle a été faite par un consultant de TOKTEN sous les auspices du Programme de développement des Nations-Unies.

Le présent rapport décrit brièvement le programme de recherche permanent de la CMRS de Dhanbad et met l'accent sur les incendies dans les mines, la combustion spontanée et le contrôle biologique du méthane.

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INTRODUCTION

An invitation was received from the Council of Scientific and Industrial Research, India, to visit Central Mining Research Station, Dhanbad for a period of six weeks under the United Nation Development Programme as a TOKTEN Consultant. The visit took place during July and August of 1988.

The main objective of the visit was to review the work of CMRS Mine Fire Laboratory, interact with the scientists and recommend measures so that R&D work related to mine fire control can be upgraded at CMRS.

This report outlines briefly the activities of Central Mining Research Station, Dhanbad, India. Emphasis is put on to the R & D work related to mine fire and environmental control.

Central Mining Research Station is the lead organization in India for carrying out R & D work related to mining. It has a total staff of about 500 which includes both professional and support staff. The R & D work at CMRS is being carried out in close collaboration with the mining industry. Both long term and short term industry problems are dealt by CMRS. In addition, services are rendered to the industry by testing and certification of flame proof equipment, wire ropes, suspension gear equipment, explosives and detonators. Functional structure of CMRS is shown in figure 1.

COAL PRODUCTION IN INDIA

India produced over 150 million tonnes of coal during 1987-88. About 50-55% of the total coal produced came from underground operations and the rest from surface mines. Most underground operations use bord and pillar method of extraction. Approximately 5 million tonnes are produced by longwall method. Barring a few fully mechanized mines most operations can be put in the category of partially mechanized. Large scale introduction of longwall mining is expected in the near future. It may also be necessary to mechanize existing mines to offset the effect of increased labour cost. Trucks and shovels used in surface operations in India are small or medium in size compared to North American practice

but it is expected that larger equipments will be progressively introduced in mining operations in India. It appears that percentages of coal produced from surface operation will increase over the next few years particularly during mining of low grade thermal coals.

R & D WORK AT CMRS

Research and Development Work done at CMRS are summarized below.

MINE FIRE AND SPONTANEOUS COMBUSTION CONTROL

The problem associated with mine fire appears to be of major concern to the coal mining operators in India. Over 34 million tons of coal were lost through mine fires and nearly 45 million tons of resources are presently blocked. About 70 fires are still active only in the Jharia coal field according to official sources, spontaneous combustion of coal is mainly responsible for most of the coal mine fires in India. The problem is particularly acute in India with its large resources of thick and low grade coal seams. As a result, CMRS has been actively engaged in R & D work related to the prevention and control of spontaneous combustion and mine fire since early sixties.

COAL CHARACTERIZATION

There is no simple way by which one can predict whether mining of a coal seam will result in spontaneous combustion. However, knowledge of the relative potential of a coal to oxidize is a useful tool for mine planning. This parameter can be used for evaluating precautions necessary during mining, storage and transportation of coal and can indicate potential fire hazards of a seam or the section of a particular seam during mining.

R & D work related to characterization of coal with respect to their susceptibility to spontaneous combustion is initiated by the Central Mining Research Station (CMRS) India in early sixties. Over the years CMRS has built up a strong knowledge base in this area which is well

recognized all over the world. A number of methods have been developed and tested and results published in reputed Indian and international journals. A book on spontaneous combustion authored by Dr. S.C. Banerjee of CMRS and published by A.A. Balkema is now available. During the visit it was advised that CMRS should initiate and collaborate with other countries towards establishing a standard experimental procedure for coal characterization which is internationally acceptable. This is being actively considered by CMRS authorities.

Many of the fires in high volatile bituminous and subbituminous coals are caused because of partial dehydration when left in dry and hot atmospheric environment common with most coalfields in India. Maintaining the equilibrium moisture by adding water periodically to the coal pile or coal benches, at times, proved useful in reducing the occurrences of spontaneous combustion in some areas but the need for a better preventive method is considered essential. The role of surfactants and inhibitors in the prevention of spontaneous combustion is presently being investigated. Particular attention is being given to the choice of surfactants, method of application and the quantity required per tonne of coal to make this technology cost effective.

EARLY DETECTION OF HEATING

Early detection of fire is of prime importance to mine operators. Any fire which can be detected at an early stage may save the facility from considerable loss or damage. Very high priority is being given to develop methods for early detection of fire and heatings all over the world. So far R & D work in this area received low priority at CMRS. Plans are now in place to put greater emphasis for R & D work related to early detection of heating.

The use of computerized monitoring system significantly improved safety records in mines. One of the major reasons for success is the ability of the monitoring system to detect heating at an early stage particularly by studying the variation of carbon monoxide in mine air at different strategic locations. Work has already been initiated at CMRS towards development of computerized environmental monitoring system using indigenous technology.

In recent years infrared scanners have been used successfully for early detection of heating in coal pillars, in fractured coal mass around stoppings, in coal benches and in coal stockpiles. Success of this technique depends on the correct interpretation of thermal image. It is now possible to have photographs or video films of the thermal image obtained during survey. Analysis of thermal image is greatly simplified and computerized trend analysis is possible. This technology was discussed in details during the visit and plans to procure necessary equipments were finalized by CMRS.

SEALANT TECHNOLOGY/CHEMICAL INFUSION

Development of sealants has contributed significantly in the control of air leakage through fractures and fissures particularly in coal pillars, coal benches and gate roads packs thereby reducing incidence of spontaneous heating. Demonstration trials for both indigenously developed sealants as well as sealants imported from abroad are being carried out by CMRS for effective application of this technology. Test results with indigenous sealants are quite encouraging. Attempts are being made for wider application of sealants in Indian coal mining operations taking into consideration of high heat and humidity conditions.

R & D work at CMRS has established that successful application of silicate injection in fractured coal pillars can prevent and control spontaneous combustion. Attempts are presently being made to evaluate possible use of silicate injection technology in coal benches to prevent onset of spontaneous combustion.

REOPENING OF SEALED OFF AREAS

Mine fire laboratory in CMRS is presently carrying out extensive studies based on actual field data to determine the status of fire in a sealed off area using established indices like CO/O_2 deficiency ratio, CO_2/O_2 deficiency ratio, alkane ratio etc. A new index for mine fire assessment based on C/H ratio calculated from compositional analysis of fire area gases has been developed. In some mines it is claimed that this index was able to predict the intensity of fire in a sealed off area more effectively. Considerable effort is also being made to establish norms for

fire affected areas under different mining conditions with special emphasis on the quality of coal mined and the humidity conditions in the sealed off area. This study will prove invaluable during reopening of districts sealed off due to fire.

RECOVERY AND CONTROL OF ABANDONED FIRE AREAS

Recovery of abandoned fire areas are difficult and often very expensive. This is an area of research where very limited expertise in a commercial sense is presently available. A detailed analysis and review of the state of the art technology and their possible applications under Indian mining conditions has been jointly undertaken by CMRS and Coal India Limited as a first step. It is further planned to carry out demonstration trials to establish suitability of various methods before a full scale attempt is made to recover some of the old fire areas in Jharia coal field where several million tonnes of coking coal are sterilized. Accelerated burn out and water infusion fume exhaution (WIFE) are some of the techniques proposed to be tested under Indian mining conditions. In view of high cost and limited possibility of success, the need for developing site specific methods is considered essential to make such efforts economically viable.

INERTIZATION

CMRS initiated some studies on the application of inert gas for fire control. Infusion of carbon dioxide in three different affected areas result in successful control of fire. In one case, shaft pillar could be saved from advancing fire and in other two cases spread of fire could be restricted in the sealed off area. There are plans to carryout more field trials to determine suitability of this method.

METHANE CONTROL

Effective control of methane in all phases of mining is considered essential for health and safety reasons. CMRS is engaged in R&D activities in this area since inception. Methane emission investigations have been conducted in 50 mines during the last decade

mainly to assist in ventilation reorganization. CMRS also assists in the design and installation of the methane drainage systems in coal mines. Some work is in progress for utilization of the drained methane gas. Work related to kinetics of methane desorption for Indian coals of different ranks are now in progress.

Since late seventies, CMRS has been engaged in the development of methods based on biotechnology for methane control in coal mines. Methane oxidizing bacteria known as Methanomonas Methanica was isolated from soils collected from marshy lands and also from mine waters taken from gassy mines. The study on the nature of these bacteria using electron microscope indicated that they are single polar flagellated bacteria which utilizes carbon of methane for its cell growth. Both aerobic and anerobic type of bacteria were isolated successfully at CMRS laboratory.

The species isolated at the initial stage were capable of thriving in a methane concentration up to 20-25%. Following mutation technique a completely new species was developed which is anerobic in nature and could grow in almost pure methane. Certain additives and nutrients proved useful for the growth and activity of the bacteria.

Field trials were carried out at 9 locations in three collieries. In one colliery the emission rate of methane in a solid coal pillar was reduced from 4.5m^3/min to 2.8 m^3/min within a month after infusion of bacteria. The methane emission from the floors of two development headings close to a dyke was reduced from 0.87 m^3/min to 0.35 m^3/min after introducing bacteria through holes in the floor.

So far no large scale laboratory test has been conducted under controlled conditions. Field results can be sometimes misleading because of varying nature of methane emission from the coal seams. It was advised that large scale demonstration tests are essential to gain industry confidence in this novel technology. So far no attempt has been made to produce methane oxidizing bacteria on a large scale using commercial size bio reactors at CMRS.

VENTILATION

Adequate ventilation is essential for safety as well as productivity in underground mining operations. Ventilation requirements often changes because of unforeseen geologic and mining conditions, changes in production strategy and degree of mechanization. Ventilation survey is considered essential before any major reorganization can be attempted.

CMRS has the know how and proper facilities for carrying out detailed ventilation survey followed by computer aided ventilation reorganization. Almost all mines take advantage of this facility at CMRS. On an average 5 complete ventilation surveys are carried out by CMRS each year.

Work is in progress to develop ventilation network programs where corrections for temperature, humidity and presence of methane can be made accurately. R & D work is also in progress to solve ventilation problems in blind headings and development galleries. Modelling for auxiliary ventilation systems and air leakage phenomenon through fractured and constricted areas is being attempted. Considerable success has been achieved by the application of pressure balancing technique in the control of mine fire.

DUST CONTROL

Along with ventilation survey dust survey work is also undertaken by CMRS. So far dust survey has been carried out in 40 coal mines and 25 non coal mines. Airborne dust concentration during different mining operations were investigated in details. Respirable dust index for different seams are being developed. Suppression of airborne dust using water mist and reduction of dust using dust collectors are being studied. Dust level is still quite high in many coal mines both on the surface and underground workings and efforts are being made to bring the airborne dust concentration to an acceptable level.

The coal dust explosion research group is carrying out R & D work on the effect of low concentrations of methane and carbon dioxide on relative flammability of coal dust. Dispersability of various fractions of

coal dust and how they effect flammability is also being investigated. The use of water barrier for the prevention of explosion propagation is also being studied in the experimental test gallery at CMRS.

GEOMECHANICS AND MINING METHOD

In general, recovery from thick seams in underground workings is usually low. In India, the percentage of recovery from thick seams has to be improved to meet the demand in coming years without sterilizing the resources. Sub-level caving with a thicker working section is considered to be an option for higher recovery. Presently this approach is not much favoured because of hard nature of coal and as such they are not amenable to cave in. R & D work is initiated to deal with this problem.

In India up till now longwall mining in one lift has been restricted to a height of about 2-3 metres. For seam thickness over 3 metres either bord and pillar or multi-slice longwall is usually practiced. Attempts are being made to try single lift longwall using greater height.

Increased depth of working and mechanized extraction often result in complex geomining conditions. Deep mining also results in stress concentration. The mechanics of time dependent deformation around deep mine opening is being studied to identify potential methods of ground control.

It is expected that roof bolting will be used extensively in mechanized mines. Attempts to develop bolting equipment for quick and safe installation of roof bolts are in progress. Non destructive methods for bolt testing is also being contemplated.

R & D efforts are being directed to introduce mechanization in the development and extraction areas maintaining large spans. This would very much depend on the successful roof control in large openings.

Equivalent material modelling technique is used extensively by CMRS to predict various parameters related to the extraction of coal seams. This resulted in increased production and reduction of stowing material requirements.

The likely behavior of strata in longwall workings could be predicted with greater accuracy using some mathematical formulation developed in CMRS based on actual field data obtained from longwall faces.

Based on triaxial strength a new approach for predicting failure of rock masses has been developed. This has also led to the development of new equations for determining the stability of mine pillars. It is claimed that the results proved very useful during pillar design.

Hydraulic stowing of sand is extensively used in India to help in the control of ground movement and to facilitate extraction of thick coal seams. CMRS has made significant contribution in the design of stowing plants and back filling at rates up to 650 tons/per hour is now possible which has resulted in improved safety as well as productivity.

REPRINTS OF REPORTS

Reprints of reports describing in details some of the topics discussed in this report are available to anyone interested.

ACKNOWLEDGEMENTS

The author would like to thank the Director and staff of CMRS for their co-operation during the visit. Most of the informations presented here were obtained during face to face discussion and from published CMRS reports.

FUNCTIONAL STRUCTURE OF CENTRAL MINING RESEARCH STATION